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Analyzing critical thinking skills using online discussion forums and CCTST

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Abstract

This research study examined the progress of critical thinking (CT) skills in a first year mathematics unit for two batches of students. Problem solving sessions in engineering mathematics were activated through two online Discussion Forums (DFs) and the student postings analysed for CT skills. Changes in participants' general CT Skills were investigated using the California Critical Thinking Skills Test (CCTST) instrument, before and after participation in the DFs. The CT skills identified through the postings from the DFs showed slight improvement over the semester. The general CT skills, as measured by the CCTST showed a progress in the total and the component scores. The study proved that online technology could facilitate development of CT skills in a slow yet steady manner, under the efficient supervision of the instructor.

*Keywords:*Critical Thinking skills, Online Discussion Forums, CCTST scores;

1. Introduction

Critical thinking (CT) should not be just another educational option, but rather an indispensable part of tertiary education, since the modern day learning environment exposes students to loads of information which requires effective cognitive strategies to process (Angeli & Valanides, 2009; Lun, Fischer & Ward, 2010). A concise definition of CT adopted in this study is "the ability to use acquired knowledge in flexible and meaningful ways, through understanding the problem or issue, evaluating evidence, considering multiple perspectives, and taking a position" (Vanderstoep&Pintrich, 2003, p. 275).Online Learning Management Systems (LMS) such as Blackboard and WebCT provide avenues for online asynchronous discussions also known as discussion forums. Discussion forums have the unique capacity to support higher-order constructivist learning and the development of a learning community (Levine, 2007). The term "online Discussion Forum" or ODFs in this study was used to mean "asynchronous online learning forum" available under the Blackboard Learning System (An, Shin, & Lim, 2009). Discussion board interaction has become the focus of studies about critical thinking and online learning as done by Yang, Newby, & Bill (2005), who measured students' CT skills using the California Critical Thinking Test (CCTST). The CCTST has been increasingly popular in measuring CT among undergraduate students as studied by Miri, David, and Uri (2007) and Al-Fadhli and Khalfan (2009). In the ongoing debate over how students might best learn CT, first year units have been explored to be key starters to begin the development of CT skills.

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Hammer and Green (2011) suggested the importance of scaffolding the development of CT skills at the unit level and to plan its development at the programme level of the discipline. The research questions addressed in this paper are: (1) Was there any progress in the level of CT skills in ODFs, that is from the first forum DF1 to the second forum DF2, as measured by the online DF postings? (2) Were there any differences in the CT skills before and after participation in ODFs, as measured by the CCTST scores at the beginning and end of the 14-week unit?

2. Research Study

The course involved in this study was the compulsory first semester engineering mathematics unit, of the Bachelor of Engineering programme offered by Swinburne University of Technology, Sarawak Campus in Malaysia. The data was collected from two batches of students of the same unit, Batch 1(50 students) and Batch 2 (60 students). The unit was predominantly conducted face-to-face over 14 weeks was supported by the Blackboard Learning System, or BBLS. Two problem solving sessions were planned on the online DFs of the BBLS at two different times (Week 4 and Week 10 respectively), as part of the infusion approach (Aizikovitsh-Udi&Amit, 2011) of fostering CT skills. The goal of these sessions was for students to work collaboratively in groups to solve application problems (M-S Chiu, 2009) and thus encourage CT skills. The first forum (DF1) carried a weightage of 7%, and the second forum (DF2) carried a weightage of 8% to encourage active participation. The instructor encouraged these collaborative sessions by moderating (scaffolding) the discussion thread in order to stimulate both mathematical learning and mathematical understanding.. All participants were new to the experience of using ODFs in the educational setting. Data was collected in this study using two modes: (1) The ODF postings; and (2) CCTST scores.

Table 1.CAIS Model to Measure CT during Online DF Sessions in Mathematics (Jacob & Sam, 2010)

Clarification - Formulates the problem precisely and clearly *(with different indicators in columns)*			
Analyses, negotiates or discusses the scope of the problem	Identifies one or more underlying assumptions in the parts of the problem.	Identifies relationships among the different parts of the problem	Defines or criticizes the definition of relevant terms
Assessment - Raises vital questions and problems within the problem.*(with different indicators in columns)*			
Gathers and assesses relevant information.	Provides or asks for reasons that proffered evidence is valid or relevant.	Make value judgment on the assessment criteria or argument or situation.	
Inference - Reasons out based on relevant criteria and standards *(with different indicators in columns)*			
Makes appropriate deductions from discussed results.	Arrives at well thought out conclusions	Makes generalizations from relevant results.	Frames relationships among the different parts of the problem.
Strategies - Thinks and suggests open mindedly within alternative systems of thought.*(with different indicators in columns)*			
Propose specific steps to lead to the solution.	Discuss possible steps.	Evaluate possible steps.	Predicts outcomes of proposed steps.

The DF postings were downloaded and subjected to qualitative and quantitative analysis. One posting (message) was considered as the unit of analysis, and was believed to be reflective of the CT processes adopted by the participants during the online DFs. The content analysis of the postings in the current study was done using the CAIS model (Jacob & Sam, 2010), which represented the categories (phases) of CT, namely Clarification, Assessment, Inference and Strategies. The model was adapted from the model proposed and tested by Perkins and Murphy (2006) and the CT concepts of Paul and Elder (2006). The higher levels of critical thinking are associated with the stages of Inference and Strategies. The model is available in Table 1. CT scores or CAIS model scores were calculated for each participant based on a weightage table associated with the four categories, as shown in Table 2. The students also took the 45-minute CCTST in class under the supervision of the researcher, before the first and after the second discussion forum, as an outcome measure. In the CCTST, CT skills are identified as Analysis, Inference, Evaluation, Induction and Deduction (Facione, Facione, Giancarlo &Blohm, 2002). The CCTST assesses an individual's or group's CT and reasoning skills. It yields a total score and norm-group percentiles, as well as subscale scores by the classical categories of inductive and deductive reasoning and by the contemporary categories of analysis, inference, and evaluation (Bers, 2005). The Inductive and Deductive scales overlap with the Analysis, Inference, and Evaluation scales The CCTST instrument was chosen over others because of its validity and reliability for measuring critical thinking and interdisciplinary aptitude.

Table 2.Scoring Table for the CT categories

Category	No. of postings	Weightage
Clarification	1-2	1
	3-4	1.5
	>4	2
Assessment	1-2	3
	3-4	3.5
	>4	4
Inference	1-2	5
	3-4	5.5
	>4	6
Strategies	1-2	7
	3-4	7.5
	>4	8

3. Results

The results have been classified into two sections – one on CT from DF postings and the other on CT from CCTST.

3.1. CT from online DF postings

The CAIS model scores, calculated as a weighted CT score based on the CAIS model, were quantitative indicators of the CT skills exhibited through the online DFs. The scores between 15- 20 indicated a high number of postings in the categories of inference and strategies.

Table 3.Descritptive Statistics of CAIS Model scores

	Batch 1 (N = 43)					Batch 2 (N = 60)				
CAIS score	**Mean**	**S.D.**	**Q1**	**Q2**	**Q3**	**Mean**	**S.D.**	**Q1**	**Q2**	**Q3**
CT1	6.56	5.230	1.00	4.5	10.50	8.33	6.045	4.00	7.00	12.00
CT2	11.36	5.302	9.00	12.00	16.50	8.76	5.112	4.50	9.50	14.25

Hypothesis 1: The CT skills do not show an improvement from Forum 1 to Forum 2;

Table 3 clearly shows the CT scores (CT1 and CT2) are higher for DF2 than that of DF1, in Batch1 and Batch2.Or, there is seen an increase in the statistics of the higher categories of critical thinking, namely inference and strategies.The hypothesis is thus rejected. Or, CT skills showed an improvement from Forum 1 to Forum 2. The external prompts, stimulus, guidance of the moderator (instructor) played an important role in encouraging group discussion and CT skills during the ODF sessions DF1 and DF2. But generally the postings fell in the lower levels of CT, as is seen from the relatively low scores for CT1 and CT2, for both batches.

3.2. CT from CCTST Results

The original hard copy CCTST Capscore forms filled in by the participants were sent to the Insight Assessment, California.The forms were evaluated and the CCTST scores were sent back to the researcher. Analysis, Inference, and Evaluation add up to the CCTST total score. Induction and Deduction also added up to the CCTST total score. The maximum possible score for the CCTST was 34 (Facione, Facione, Giancarlo &Blohm, 2002). Each participant

who has attempted the CCTST has a pre score and a post score for Analysis, Inference, Evaluation, Induction and Deduction and a total score. A participant who scored a total CCTST score (referred to as Total) above 20 was considered to have high CT skills, as was evident from Facione et al. (2002).

The Total pre and post mean scores of Batch 1 and Batch 2 were below the critical score of 20. But the detailed statistics, shown in Table 4 confirmed that post-CCTST Total scores increased from the pre-CCTST Total scores for Batch 1 and Batch 2, with small variability as seen from the S.D. (standard deviation) and quartile measures. For Batch 1, the Total mean score increased from 13.76 (S.D. = 3.420) to 15.62 (S.D. = 4.367). For Batch 2, the Total score increased from 15.93 (S.D. = 3.703) to 16.93 (S.D. = 4.909). The mean scores of the sub scales like Analysis, Inference, Evaluation, Induction and Deduction have also shown improvement. The paired t-tests done on the CCTST scores of Batch 1 proved to be significant for the Total scores ($t(41) = -4.067$, $p = 0.013$), Inference scores ($t(41) = -4.831$, $p < 0.005$), and Deduction scores ($t(41) = -4.867$, $p < 0.005$). The paired t-tests done on the CCTST scores of Batch 2, proved to be significant for the Total scores ($t(56) = -2.400$, $p = 0.020$), and Deduction scores ($t(56) = -2.313$, $p = 0.024$).. For Batch 1 and Batch 2, the highest mean score among the subscales occurred for Induction, followed by Inference and Deduction subscales.

Hypothesis 2: There is no significant difference in the CT skills of students before and after participation in the ODFs.

Hypothesis 2 was rejected at 5% significance level, from the paired t-test results. Or, there were significant differences in CT skills before and after participation in the ODFs.The general CT skills, as measured by the CCTST showed a progress in the total and the component scores, from the beginning to the end of the instructional term of 14 weeks. Thus participants have moved on from their original level of CT skills to a higher level, as they completed the unit. The progress in the CT skills could be partially attributed to the online DF assessments taken by the participants.

Table 4.Descriptive Statistics of CCTST Scores – Batch 1 and Batch 2

	Batch 1 (N=43)						Batch 2(N=60)					
Category	**Q1**	**Q2**	**Q3**	**Mean**	**S.D.**	**p**	**Q1**	**Q2**	**Q3**	**Mean**	**S.D.**	**p**
Total-pre	11	14	16	13.76	3.420	0.000	14	16	18	15.93	3.703	0.020
Total-post	12	16	19	15.62	4.367		14	17	20	16.93	4.909	
Analysis-pre	3	4	5	3.95	1.481	0.235	3	4	5	4.28	1.211	0.851
Analysis-post	3	4	5	4.24	1.511		4	4	5	4.34	1.148	
Inference-pre	5	6	8	6.31	2.006	0.000	6.25	8	9.75	7.88	2.363	0.055
Inference-post	6	7.50	9	7.43	2.481		6	8	10	8.40	2.883	
Evaluation-pre	2	3.50	4	3.50	1.612	0.103	3	4	5	3.78	1.644	0.127
Evaluation-post	3	4	5	3.95	1.637		3	4	5.75	4.19	2.131	
Induction-pre	6	8	10	8.00	2.198	0.115	7	9	11	8.66	2.236	0.234
Induction-post	7	9	10	8.52	2.371		7	9	11	9.00	2.485	
Deduction-pre	4	6	7	5.76	2.239	0.000	6	7	9	7.28	2.254	0.024
Deduction-post	5	7	9	7.10	2.878		6	8	9	7.93	3.043	

4. Conclusions

The study was an attempt to measure CT skills in an engineering mathematics unit. CT skills specific to mathematics problem solving were measured from the classification of the online DF postings using the CAIS model. The weighted CT scores have improved from DF1 to DF2, though the majority of the postings fell into the lower phases of CT. The findings were in line with those by Fahy (2005), Garrison et al. (2001), Oriogun (2007), and Schrire (2006), who found that the online discussion transcripts associated with higher phases of CT were remarkably small. The general CT skills measured using the CCTST prior and after the online DF sessions showed significant improvement from the pre test scores to the post test scores. The pre and post CCTST scores of the Batch 1 and Batch 2 participants were typically low of first year university students, as reported by Chiu (2006) and Chiu (Y-C. J. Chiu, 2009), in their study of online discussions. The CCTST scores of the present study were compared with those reported by previous studies were comparable with the scores, Mean = 15.89 (S.D. = 4.46) reported by

Facione(2010) in the United States of America. Miri, David, and Uri (2007) tested the CCTST with an experimental group of students involving real-world problems, open-ended class discussions, and inquiry-oriented experiments, and found the experimental group to have a CCTST mean score of 16.86 (S.D. = 3.23) for the post-test scores and mean of 9.75 (SD = 3.33) for the pre-test scores. CCTST was used by Al-Fadhli and Khalfan (2009) to show the effectiveness of the e-learning model (mean total score of 13.56) over the traditional method of teaching (mean total score of 12.44), and improvement in analysis and deduction skills The current study indicated that student participants could collaborate to learn and enhance their CT skills, while enjoying the challenge of collaboration. Such studies should continue to explore the possibilities of enhancing CT skills among tertiary students.

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References

An, H., Shin, S., & Lim, K. (2009).The effects of different instructor facilitation approaches on students' interactions during asynchronous online discussions, *Computers & Education*,*53*(1), 749-760.

Angeli, C. &Valanides, N. (2009). Instructional Effects on Critical Thinking: Performance on Ill-defined Issues. *Learning and Instruction, 19*(1), 322-334.

Al-Fadhli, S., &Khalfan, A. (2009).Developing critical thinking in e-learning environment: Kuwait University as a case study. Assessment & Evaluation in Higher Education, 34(5), 529-536.

Bers, T. (2005).Assessing critical thinking in community colleges. New Directions for Community Colleges, 130, 15-25.

Chiu, Y-C.J. (2006).Exploring student and teacher interactions for critical thinking in face-to-face and online environments in an EFL course in Taiwan.Unpublished doctoral dissertation, Australian Catholic University, Australia.

Chiu, Y-C.J. (2009).Exploring pedagogical strategies to integrate a holistic approach to education into ESL classes. Asia Pacific Education Review, 10(2), 261-270.

Facione, P. A., Facione, N., Giancarlo, C., &Blohm, S. (2002). The California critical thinking skills test:Test manual. Millbrae, CA: California Academic Press LLP.

Facione, P. A. (2010). Critical thinking: What it is and why it counts. California Academic Press. Retrieved January 10, 2010 from http://www.insightassessment.com/pdf_files/what&why2010.pdf.

Fahy, P. J. (2005). Two methods for assessing critical thinking in computer –mediated communications (CMC) transcripts.International Journal of Instructional Technology and Distance Learning, 2(3). Retrieved June 7, 2007 from http://itdl.org/Journal/Feb_07/article02.htm

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *The American Journal of Distance Education, 15*(1), 7-23.

Hammer, S. J. & Green, W. (2011). Critical thinking in a first year management unit: the relationship between disciplinary learning, academic literacy and learning progression. *Higher Education Research & Development, 30*(3), 303-315.

Jacob, S.M, & Sam, H.K. (2010). Perspectives on crtical thinking through online discussion forums in engineering mathematics, In K. Elleithy, T. Sobh, M. Iskander, V. Kapila, M.A. Karim, & A. Mahmood (Eds.), *Technological developments in networking, education and automation* (pp. 121-126). Netherlands: Springer.

Levine, S.J. (2007).The online discussion board, *New Directions for Adult and Continuing Education, 113,* 67- 74.

Lun, V. M. C., Fischer, R. & Ward, C. (2010). Exploring Cultural Differences in Critical Thinking: Is it about my Thinking Style or the Language I speak?

Miri, B., David, B-C., & Uri, Z. (2007).Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking. Research in Science Education, 37(4), 353-369.

Oriogun, P. K. (2007). Assessing critical thinking in a new approach to computer-mediated communication (CMC) transcripts.International Journal of Instructional Technology & Distance Learning, 4(2). Retrieved December 9, 2007 from http://www.itdl.org/Journal/Feb_07/index.htm

Schrire, S. (2006). Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis, *Computers & Education*, *46*(1), 49-70.

VanderStoep, S., &Pintrich, P. (2003).Learning to learn: The skill and will of college success. Upper Saddle River, NJ: Prentice Hall.

Yang, Y-T.C., Newby, T. J., & Bill, R. L. (2005).Using Socratic questioning to promote critical thinking skills in asynchronous discussion forums in distance learning environments. American Journal of Distance Education, 19(3), 163-181.